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ART UNIT	**PAPER NUMBER**
2628	

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Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)
	10/500,772	STEPHENSON, PETER
	Examiner	Art Unit
	Said Broome	2628

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *28 July 2006*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-18* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-18* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

Response to Amendment

1. This office action is in response to an amendment filed 7/28/2006.

2. Claim 1 has been amended by the applicant.

3. Claims 2-18 are original.

Claim Rejections - 35 USC § 112

The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

Claims 12-18 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite in that it fails to point out what is disclosed by the claim language. It is unclear from the language recited in claim 12 in lines 3-4 "a ray interesting one or more of the first runs and being defined as a set of second runs of voxels", specifically how the second runs of voxels are defined. For example, if the first run of voxels are defined as Ray 1, and the second runs of voxels are defined from the first runs, it is therefore unclear as to where the second runs of voxels are defined as equivalent to the first runs as Ray 1, or if the second runs of voxels are defined differently as a Ray 2. Therefore claims 12-18 are rejected under 35 U.S.C. 112 second paragraph because the claim language is indefinite.

Claim Rejections - 35 USC § 101

35 U.S.C. 101 reads as follows:

> Whoever invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof, may obtain a patent therefor, subject to the conditions and requirements of this title.

Claims 1-18 are rejected under 35 U.S.C. 101 because the claimed invention is directed to non-statutory subject matter. The claim teaches a method practiced in a computer system of determining voxels in an object space that are traversed with a ray to determine intersections with the ray however, no useful, concrete and tangible result is produced because the data is not used to provide a generated display or other indication of resulting detected intersections. Therefore, the claimed invention does not posses "real world" value, and instead represents nothing more than a process of determining intersections based on the analysis performed on the claims with respect to the questions proposed on page 30, in the last box of the Interim Guidelines. For example, the questions proposed were: Does the Claimed Invention Fall Within an Enumerated Statutory Category? Yes, because the claim recites a method, which falls within the statutory category, is practiced in a computer system. Next, Does the Claimed Invention Fall With a 101 Judicial Exception – Law of nature, Natural Phenomena or Abstract Idea? Yes, because a method practiced in a computer system is an abstract idea i.e., a computer program. Therefore the determination to reject claims 1-18 was based on the question: Practical Application That Produces a Useful, Tangible, and Concrete Result?, in which the answer was determined as No because the examination of data associated with intersected voxels, as recited in claim 1, is not a tangible, concrete result and is simply an abstract idea.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claims 1, 2, 10 and 11 are rejected under 35 U.S.C. 103(a) as being unpatentable over Schroder et al. (herein "Schroder", "Data Parallel Volume Rendering as Line Drawing").

Regarding claim 1, Schroder teaches making projections of the ray on a plurality of planes in the object space(on page 25 first column first paragraph lines 2-9 "...line drawing to traverse the data set when evaluating the path integrals corresponding to a raytracing of the volume...rays of a parallel projection correspond to a single line instance multiple times across the viewing plane...", and the ray is also shown projected through several planes in the object space in Figure 3); determining cells in the planes that are intersected by the projections (Figure 1, "All rays start from the image "line" and are chosen such that they intersect the outermost column of pixels...Each ray enumerates the voxels it steps through."); and using the intersected cells to determine the intersected voxels(section 2 second paragraph lines 2-7, "Each ray starts in the image line(plane) and steps toward the volume...rays will enter the frontmost column(face) of the image (volume) with the same pixel(voxel) coordinate.") and on page 29 first column third paragraph line 8("...the intersections are evaluated..."). Though Schroder does not explicitly teach examining the data associated with the intersected voxels to determine how the ray is affected, it would have been obvious to one of ordinary skill in the art to analyze the intersected voxels, as described in section 2 2nd paragraph lines 2-6 ("Each ray starts in the image line (plane) and steps towards the volume...all rays will enter the frontmost column (face) of the image (volume) with the same pixel (voxel)..."), to determine how the ray is affected, as shown in Figure 1 where voxels affected by the ray are shaded gray.

Regarding claim 2, Schroder illustrates determining a set of runs of cells, which are rows of pixels containing the same y coordinate, that are intersected by the projection of the ray in Figure 1.

Regarding claim 10, Schroder illustrates an object space that has a major axis relative to the ray in Figure 1. Schroder also teaches a plurality of planes as two planes which intersect along the major axis, as shown in Figure 6, where it is shown that the frontmost face of the cell is contained on one plane of the major axis and intersects the rightmost face is contained on another plane of the major axis at the bottom right point of the voxel.

Regarding claim 11, Schroder illustrates in Figure 6 two planes, one of the frontmost face of the cell along the major axis and one of the rightmost face along the major axis, where the planes are shown to intersect at right angles.

Claims 3 and 6 are rejected under 35 U.S.C. 103(a) as being unpatentable over Schroder in view of Stephenson et al. (herein "Stephson", "Why Step When You Can Run?").

Regarding claim 3, Schroder fails to teach runs that have an order greater than 1. Stephenson illustrates runs that have an order greater than 1 in Figure 4 where runs of order 2 are shown. It would have been obvious to one of ordinary skill in the art to combine the teachings of Schroder and Stephenson because this combination would provide more efficient analysis of the line by using higher orders than 1.

Regarding claim 6, Schroder teaches a set of runs for a given projection are determined in parallel (on page 25 first column first paragraph lines 2-9 "...line drawing to traverse the data set when evaluating the path integrals corresponding to a raytracing of the volume...rays of a

parallel projection correspond to a single line instance multiple times across the viewing plane…"), and it is also illustrated in Figure 1. However, Schroder fails to teach determining a set of runs for a given projection in parallel. Stephenson teaches determining a set of runs for a given projection in parallel on page 83 second column fifth paragraph lines 2-4("line drawing and ray traversal through a 2D lattice, producing both sequential and parallel algorithms"), and is also illustrated in Figure 4. It would have been obvious to one of ordinary skill in the art to combine the teachings of Schroder and Stephenson because this combination would provide the ability to investigate several ray intersections.

Claims 7-9 are rejected under 35 U.S.C. 103(a) as being unpatentable over Schroder in view of Kaufman et al. (herein "Kaufman", US Patent 5,442,733).

Regarding claim 7, Schroder fails to teach the step of using the intersected cells to determine the intersected voxels further includes the step of determining whether the intersected voxels are edge-connected or corner-connected. Kaufman teaches in column 6 lines 14-18("The three kinds of neighboring voxels defined above can be specified in terms of whether voxels share a face (i.e., a surface), a side (i.e., edge) or a corner (i.e., a point) with a neighboring voxel…"), where it is described that intersected voxels may be determined to be either edge-connected or corner-connected. It would have been obvious to one of ordinary skill in the art to combine the teachings of Schroder and Kaufman because this combination would provide accurate calculation of the position at which voxels touch each other thereby providing which regions of the volume data contain contents of an object.

Regarding claim 8, Schroder fails to teach in the step of determining whether the intersected voxels are edge-connected or corner connected, if one of the first-order runs of cells has a corner connection at a point and the other first order run of cells does not have a corner connection at the corresponding point, the intersected voxels have an edge connection at the corresponding point. Kaufman teaches in the step of determining whether the intersected voxels are edge-connected or corner connected, if one of the first-order runs of cells has a corner connection at a point and the other first order run of cells does not have a corner connection at the corresponding point, the intersected voxels have an edge connection at the corresponding point in Figure 2B, where it is shown that cells that cells do not have corner connections, and are therefore edge connecting, as described in column 4 lines 7-8 ("FIG. 2B is a schematic representation of some voxels that share a edge") and column 6 lines 14-18 ("The three kinds of neighboring voxels defined above can be specified in terms of whether voxels share a face (i.e., a surface), a side (i.e., edge) or a corner (i.e., a point) with a neighboring voxel…"). The motivation to combine the teachings of Schroder and Kaufman is equivalent to the motivation of claim 7.

Regarding claim 9, Schroder fails to teach in the step of determining whether the intersected voxels are edge-connected or corner connected, if both of the first-order runs of cells have corner connections at a corresponding point, the intersected voxels have a corner connection at the corresponding point. Kaufman illustrates if both of the first-order runs of cells have corner connections at a corresponding point, the intersected voxels have a corner connection at the corresponding point in Figure 2C, and is described in column 4 lines 9-10 ("FIG. 2C is a schematic representation of some voxels that share a corner ")and column 6 lines

14-18 ("The three kinds of neighboring voxels defined above can be specified in terms of whether voxels share a face (i.e., a surface), a side (i.e., edge) or a corner (i.e., a point) with a neighboring voxel…"). The motivation to combine the teachings of Schroder and Kaufman is equivalent to the motivation of claim 7.

Claims 12-14 and 16-18 are rejected under 35 U.S.C. 103(a) as being unpatentable over Lacroute("Fast Volume Rendering Using a Shear-Warp Factorization of the Viewing Transformation") in view of Schroder.

Regarding claim 12, Lacroute teaches all the limitations except a method practiced in a computer system of traversing a volume with a particular ray of a plurality thereof and a volume being subdivided into first runs of voxels. Lacroute teaches certain voxels associated with data that affects rays, such as the determination of whether the voxels are transparent, as shown in Figure 5 and as described on page 5 first column second paragraph lines 8-12 ("to render voxels from an unencoded 3D voxel array. The array is traversed scanline by scanline. For each scanline we use the octree and the summed area table to determine which portions of the scanline are non-transparent."). Lacroute also teaches a ray intersecting one or more of the first runs and being defined as a set of second runs of voxels on page 5 first column step 3 where it is described that an algorithm subdivides the scanline, or row of volume data, therefore the first run, or row of volume data, is defined as a second run of voxels. Lacroute illustrates determining whether the second run includes a voxel of a first run that affects the rays, in Figure 5, where it is shown that a voxel scan line or first run of voxels, is subdivided into a set of second runs of voxels in which it is determined which voxels included in the original voxel scanline affect the ray. Lacroute

also illustrates that when the second run includes such a voxel, examining the associated data in Figure 4 where it is shown that when it is determined that the particular voxel is visible, it is examined and then skipped("Offsets stored with opaque pixels in the intermediate image allow occluded voxels to be skipped efficiently"). Again, Lacroute fails to teach a method practiced in a computer system of traversing a volume with a particular ray of a plurality thereof and a volume being subdivided into first runs of voxels. Schroder a method practiced in a computer system of traversing a volume with a particular ray of a plurality thereof (on page 25 first column first paragraph lines 2-9 "The algorithm uses the idiom line drawing to traverse the data set when evaluating the path integrals corresponding to a raytracing of the volume…We have implemented this algorithm on the Princeton Engine (PE) and the Connection Machine CM2 computers…") and a volume being subdivided into first runs of voxels(section 2 second paragraph lines 2-6 "Each ray starts in the image line (plane) and steps towards the volume... all rays will enter the frontmost column (face) of the image (volume) with the same pixel (voxel)…"). It would have been obvious to one of ordinary skill in the art to combine the teachings of Lacroute and Schroder because this combination would provide efficient analysis of voxels that affect a ray, through determining the transparency of the voxels.

Regarding claim 13, Lacroute illustrates first runs containing significant runs that include certain voxels in Figure 5, where it is shown that first runs, or rows of voxels, contain significant runs, which are runs that contain voxels who affect the ray in that they signify which voxels as non-transparent or visible voxels.

Regarding claim 14, Lacroute fails to teach that the volume has an axis that is the major axis for both the particular ray and the first runs of voxels. Schroder teaches the volume, in

section 2 second paragraph lines ("...the rays with a spacing in the image line such that their vertical distance is 1 (see Figure 1): then all rays will enter the frontmost column (face) of the image (volume)..."), has an axis that is the major axis for both the particular ray and the first runs of voxels, as shown in Figure 1. The motivation to combine the teachings of Lacroute and Schroder is equivalent to the motivation of claim 12.

Regarding claim 16, Lacroute teaches aggregate information is associated with partitions of the first runs, the aggregate information associated with a partition indicating how one or more voxels in the partition affect rays in section 3.3 third paragraph lines 1-4("...space into transparent and non-transparent regions, and our goal is to decide quickly which portions of a given scanline contain voxels in the non-transparent regions of the feature space."), where it is described that aggregate information, or data that provides how the voxels affect the ray, is associated with partitioned regions, as illustrated in Figure 4. Lacroute also teaches in the step of determining whether second run includes a voxel of a first run that affects rays, in section 3.3 fourth paragraph steps 2 and 3 respectively("Determine if the region is transparent,...", "Subdivide the scanline and repeat this algorithm recursively..."), where it is described that a voxel scanline or run of voxels is subdivided into a second set of runs where the determination of whether or not the voxels are transparent are recursively determined. Lacroute illustrates the aggregate information associated with a partition, as illustrated in the partitioned voxel scanline of Figure 5, is used to determine whether the partition contains a voxel that affects the particular ray, where it is shown that it determines whether or not the voxel is transparent.

Regarding claim 17, Lacroute illustrates a first run has associated therewith a plurality of sets of partitions, the partitions in each set having a different length in voxels in Figure 5.

Lacroute teaches the step of determining includes the step of selecting one of the sets of partitions in accordance with the lengths of the second runs in the particular ray, in section 3.3 fourth paragraph page 5 step 3("If the size of the current scanline portion is below a threshold then render it instead of subdividing."), where it is described that the lengths of the portioned runs determined which runs are chosen for rendering.

Regarding claim 18, Lacroute teaches aggregate information is associated with the significant runs, the aggregate information associated with the significant run indicating how one or more voxels in the partition affect rays, which are runs that provide information regarding which voxels are transparent, as described in section 3.3 second paragraph lines 3-6 ("...a new method to determine which portions of each scanline are nontransparent...") and third paragraph lines 1-4 ("...partitions a multidimensional feature space into transparent and non-transparent regions..."), and as shown in Figure 5. Lacroute also teaches the step of determining whether second run includes a voxel of a first run that affects rays includes using the aggregate information associated with a significant run to determine whether the significant run contains a voxel that affects the particular ray in Figure 5 where it is shown that a voxel scanline is divided into a set of runs of voxels which are partitioned in terms whether or not they are transparent.

Claim 15 is rejected under 35 U.S.C. 103(a) as being unpatentable over Lacroute in view of Schroder in further view of Cohen-Or et al. (herein "Cohen-Or", "An Incremental Alignment Algorithm for Parallel Volume Rendering").

Regarding claim 15, Lacroute and Schroder fail to teach three sets of first runs, each set thereof having a different axis of the volume as its major axis. Cohen-Or illustrates in Figure 5,

sets of runs (a) and (d) each having a different axis(z and x respectively) of the volume(section 4 first paragraph line 4 "The 2D lines are analogs of the rays that traverse the volume in the 3D case.") as its major axis(page 3 section 3 first paragraph line 3 "the volume data is distributed along the major axis"), and also teaches that the major axis associated with sets of runs, which are rows of pixels, may be changed, as described on page 6 section 5 first paragraph lines 4-6("...difference is caused by the choice of major axis... "). Therefore Cohen-Or also teaches three sets of runs through providing the choice of major axis for a particular set of runs, which would enable a third set containing the y axis as its major axis. It would have been obvious to one of ordinary skill in the art to combine the teachings of Lacroute, Schroder and Cohen-Or because this combination would provide separate major axes for three sets of runs thereby enabling an expansive determination of voxel data that affects a ray from any major axis orientation.

Response to Arguments

Applicant's arguments filed on 7/28/2006 with respect to claims 1-18 have been considered but are moot in view of the new ground(s) of rejection.

The applicant argues that claim 1 does not set forth a judicial exception to statutory subject matter. However, the examiner maintains the rejection because claims 1 and 12 fall within a judicial exception because the claims recite a method practiced in a computer system, which is an abstract idea i.e., a computer program. Therefore no useful, concrete and tangible result is produced because the data is not used to provide a generated display or other indication of resulting detected intersections. Therefore, the claimed invention does not posses "real

world" value, and instead represents nothing more than a process of determining intersections based on the analysis performed on the claims with respect to the questions proposed on page 30, in the last box of the Interim Guidelines.

The applicant argues that the reference Schroder used in the 35 U.S.C. 103(a) rejection of claim 1 does not teach making linear projections of the ray on a plurality of planes in the object space. The examiner maintains the rejection because Schroder teaches making linear projections of the ray on a plurality of planes in section 2 2nd paragraph lines 2-6 ("Each ray starts in the image line (plane) and steps towards the volume...all rays will enter the frontmost column (face) of the image (volume) with the same pixel (voxel)..."), where it is described that ray that intersect voxels are projected onto a particular plane, as shown in Figure 1, therefore one of ordinary skill in the art at the time of invention would have been capable of projecting the rays onto other various planes of interest as well because the image space is separated into several volumetric planes, as described in section 1.2 3rd paragraph lines 1-3 ("...the volume is treated as a set of planes...").

The applicant also argues that the references Schroder in view of Kaufman used in the 35 U.S.C. 103(a) rejection of claims 7-9 do not teach determining from the intersected cells whether the voxels are edge connected or corner connected. The examiner maintains the rejection because Kaufman teaches determining the connectivity of voxels by using intersected cells in column lines ("FIG. 5B illustrates a "thick" surface having 6-connected voxels...The decision as to which surface connectivity to use depends primarily on the connectivity of the discrete rays employed to detect surfaces during ray tracing."), where it is described that connectivity information is gathered based on ray intersections through the voxels. Therefore the connectivity

of the voxel maybe determined from the intersected cells, such as edge connection or corner connection, as described in column 6 lines 14-18("The three kinds of neighboring voxels defined above can be specified in terms of whether voxels share a face (i.e., a surface), a side (i.e., edge) or a corner (i.e., a point) with a neighboring voxel…"), where it is described that the connectivity property intersected voxels may be determined to be either edge-connected or corner-connected.

The applicant argues that the reference Schroder used in the 35 U.S.C. 103(a) rejection of claim 1 does not teach projections of the ray. The examiner maintains the rejection because Schroder teaches projections of the ray on a plurality of planes in section 2 2nd paragraph lines 2-6 ("Each ray starts in the image line (plane) and steps towards the volume…all rays will enter the frontmost column (face) of the image (volume) with the same pixel (voxel)…"), where it is described that ray that intersect voxels are projected onto a particular plane, as shown in Figure 1, therefore one of ordinary skill in the art at the time of invention would have been capable of projecting the rays onto other various planes of interest as well because the image space is separated into several volumetric planes, as described in section 1.2 3rd paragraph lines 1-3 ("…the volume is treated as a set of planes…").

The applicant also argues that the references Lacroute in view of Schroder used in the 35 U.S.C. 103(a) rejection of claims 12 do not teach for a second run belonging to a particular ray, determine whether the second run includes a voxel of a first run that affects rays. The examiner maintains the rejection because Lacroute illustrates determining whether a second run includes a voxel of a first run that affects the rays, in Figure 5, where it is shown that a voxel scan line or first run of voxels, is subdivided into a set of second runs of voxels in which it is determined which voxels included in the original voxel scanline affect the ray, as shown in Figure 5 where

the second run or intermediate image scanline is compared in parallel with a first run, or voxel scanline.

Conclusion

Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Said Broome whose telephone number is (571)272-2931. The examiner can normally be reached on 8:30am-5pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Ulka Chauhan can be reached on (571)272-7782. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

S. Broome SB
10/30/06

KEE M. TUNG
SUPERVISORY PATENT EXAMINER